Summer of Innovation

Life Science
4th – 9th grade

Introduction

The goal of the NASA Summer of Innovation Life Science camp is to excite young minds and inspire student trainees toward future science, technology, engineering, and mathematics (STEM) pursuits. Raising trainee achievement in STEM pursuits begins by leading them on a journey of understanding through these highly engaging activities. The activities and experiences in this guide come from across NASA's vast collection of educational materials.

This themed camp outline provides examples of one-day, three-day, and weeklong science and engineering programs. Each day contains 6-8 hours of activities totaling more than 35 hours of instructional time. The camp template will assist you in developing an appropriate learning progression focusing on the concepts necessary to engage in learning about life science. The Life Science camp provides an interactive set of learning experiences that center on the characteristics of living things, astrobiology, exoplanets, and adaptations to the space environment. The activities scaffold to include cooperative learning, problem solving, critical thinking, and hands-on experiences. As each activity progresses, the conceptual challenges increase, offering trainees full immersion in the topics.

Intended Learning Experiences

Through the participation in these camps future scientists and engineers will have the opportunity to explore life science. Student trainees gain learning experiences that help make scientific careers something they can envision in their lives. Trainees realize that they have the potential to make a contribution to this field and ignite their curiosity to see what they might create during the program. The learning experiences also anticipate that trainees will have the opportunity to answer the following questions:

- What is life?
- What does life require?
- Which planets and moons might be habitable?
- How do Earth's extremophiles support the idea of extraterrestrial life?
- What are the possibilities for life elsewhere in our solar system?
- How can we live in space?

Professional Development

Educator Professional Development (PD) experiences are available. Webinars, NASA Digital Learning Network (DLN) programs, training videos, and online meeting spaces will help you implement the program. We hope that you and your students have a memorable and successful experience implementing these activities.

Professional Development Resources

- The NASA Educator Online Network is a great resource for STEM educators to share and learn about STEM topics. The Life Science camp hosts a group that will provide a place for sharing about the activities, additional resources, extension ideas, and support.
- Visit the Summer of Innovation homepage for an extensive catalog of news, media resources, and educational materials.

Format of the Guide

The Six E's
Each day or section of activities utilizes the 5-E Instructional Model. Included in this program guide is a sixth 'E' for Excite. This additional 'E' shows you how to incorporate NASA's unique information and resources to excite students with career connections, real world examples, spinoffs from NASA research, and more. Learn more about the 5-E Instructional Model.

$ Requires simple materials common in the classroom or relatively inexpensive to obtain.

$$ Requires purchasing unique materials such as poster board, duct tape, or hot glue guns.

$$$ Requires purchasing or building higher-cost items, though many are one-time purchases that may used for many students over several years.

Title	Overview	Time	Cost	Additional Resources
The title hyperlinks to the activity.	An overview describes the main concepts and strategies used in the lesson, activity, or demonstration.	The time listed includes time for an introduction, activity time, and conclusion time.	Please find this camp or the activity you are using in the Resource Repository for more information on costs and tips.	Suggested resources may include additional lesson plans, posters, images, or other learning support materials.

Engage: Question?

Icons may appear throughout the program


A computer symbol means you may need one or more computers to complete the activity, though alternatives are available.


The pencil icon helps to identify the journal


The poster icon indicates that the projects the students produce make excellent station displays or decorations for a showcase event.

Journal

Journals are an optional element of your camp. Throughout the camp template, you will find reflective questions, ideas, and guidance in creating a journal. Journals also provide trainees with a unique souvenir of their experiences. Learn more about how scientists and engineers use journaling at NASA by watching this eClip video: Journaling in Space.

One-Day Camp: Life Science

In this camp, trainees think about the choices people make concerning the environments they choose to live in. Trainees then relate the information to the possibility of life on other worlds.

Title	Overview	Time	Cost	Additional Resources
Engage: Life here and elsewhere?				
Opening Activity Astrobiology: Science Learning Activities for Afterschool curriculum guide	Each student trainee, getting a sticky note, makes a giant graph on the board to answer the question: Do you believe in the possibility of alien life: Yes, No, Maybe. Digital cameras can be used to take student photos and print them for their journals.	0.5 hrs	$	Trainees make a Science Journal. Draw a picture of an alien in your journal (or as the cover of your journal) – something you think most people might see on another planet or in space. Describe each part on it, and why you added those parts.
Engage: Where do we choose to live and why?				
Where Do We Choose To Live and Why? United States at Night	Trainees construct an image of the United States at night to learn about human settlement on Earth based on the pattern of lights observable and make inferences based on their observations.	1.0 hrs	$	**Journal:** From space, could this poster be evidence of life on Earth? What do the patterns you see? Why do people live where they do? Can you determine the path of human settlements in the US based on patterns you observe?
Explore: What is life?				

Activity: Is it Living? Astrobiology: Science Learning Activities for Afterschool curriculum guide	Trainees go outside to observe and study living things defining what is “alive” and what is not alive. The activity helps them refine their understanding of life.	0.5 hrs	$	
Explain: What is Astrobiology?				
What is Astrobiology? Video: Life Built with Toxic Chemicals	Trainees get background information on what Astrobiology is and why it is important.	0.5 hrs	$	**Journal:** Why was it hard to determine which of the items you viewed were living? Can you think of other objects that would be difficult to determine if they are alive or not? What about each item would make it difficult? 
Elaborate: What Is life?				
Creature Feature	This activity is made up of four parts. The "Truth is Out There" is an activity that challenges the trainees to use appropriate descriptive language in a scientific observation. The "Who Knows?" activity provides the opportunity for one student to draw a creature being described by another student. "Tell it Like it is!" encourages the proper use of scientific instruments in collecting detailed data in an observation. The "Truth Revealed" is the assessment phase of the activity that looks specifically at the completeness of the student observations.	1.0 hrs	$	
Evaluate: What does life need to live?				

Activity 4: What can life tolerate? Pages 37–48	Working as a group, trainees explore what makes a world habitable by matching planet cards and inferring habitability based on what they have learned about life on earth. Trainees then match sets of cards to determine that organisms living under extreme conditions on Earth can serve as analogs for extraterrestrial life.	1.5 hrs	$	**Journal:** How does this change your "rules" for where to look on other worlds for living organisms? Does it change the way you would draw an alien? 
Culminating Activity: Now what do you think about the possibility of life on earth and elsewhere?				
Create a Biosphere Don't Burst My Bubble NASA "Why" Files Inhabitable Habitat	Each student now gets their sticky note from the giant graph on the board that they made in the morning and once again answers the question: Do you believe in the possibility of alien life: Yes, No, Maybe Culminating activity: Trainees will create their own worlds, and a variety of types of beings that could live on them. Using a tarp, trainees create a Biosphere.	1.0 hrs	$$ 	 **Tip:** Trainees should be prepared to demonstrate and describe for their parents in an open house or at home. **Journal:** What surprised you about today's activity? Where on Earth would you feel most comfortable living and why? 

Three-Day Camp – Day One: Life Science

In this camp, trainees think about the choices people make about the environments they choose to live in. Later in the camp we can use that understanding to begin to think about how to look for life on other worlds.

Title	Overview	Time	Cost	Additional Resources
Opener: Life here and elsewhere?				
Opening Activity Astrobiology: Science Learning Activities for Afterschool curriculum guide	Each student trainee, getting a sticky note, makes a giant graph on the board to answer the question: Do you believe in the possibility of alien life: Yes, No, Maybe. Digital cameras can be used to take student photos and print them for their notebooks.	0.5 hrs	$ 	Trainees make a Science Journal. Draw a picture of an alien in your journal (or as the cover of your journal) – something you think most people might see on another planet or in space. Describe each part on it, and why you added those parts. You can also use internet images to decorate your notebooks. 
Engage: Where do we choose to live and why?				
Where Do We Choose To Live and Why? United States at Night	Trainees construct an image of the United States at night to learn about human settlement on Earth based on the pattern of lights observable and make inferences based on their observations.	1.0 hrs	$	**Journal:** From space, could this poster be evidence of life on Earth? What do the patterns you see? Why do people live where they do? Can you determine the path of human settlements in the US based on patterns you observe? 
Explore: What is life?				

Activity: Is it Living? Astrobiology: Science Learning Activities for Afterschool curriculum guide	Trainees go outside to observe and study living things defining what is “alive” and what is not. This helps them refine their understanding of life.	0.5 hrs	$	**Journal:** Why was it hard to determine which of the items you viewed were living? Can you think of other objects that would be difficult to determine if they are alive or not? What about each would make them difficult? 
Explain: What is Astrobiology?				
What is Astrobiology? Video: Life Built with Toxic Chemicals	Trainees get background information on what Astrobiology is and why it is important.	0.5 hrs	$ 	
Elaborate: What Is life?				
Creature Feature	This activity is made up of four parts. The "Truth is Out There" is an activity that challenges the trainees to use appropriate descriptive language in a scientific observation. The "Who Knows?" activity provides the opportunity for one student to draw a creature being described by another student. "Tell it Like it is!" encourages the proper use of scientific instruments in collecting detailed data in an observation. The "Truth Revealed" is the assessment phase of the activity that looks specifically at the completeness of the student observations.	1.0 hrs	$ 	
Evaluate: What does life need to live?				

Activity 4: What can life tolerate? Pages 37–48	Working as a group, trainees explore what makes a world habitable by matching planet cards and inferring habitability based on what they have learned about life on earth. Trainees then match sets of cards to determine that organisms living under extreme conditions on Earth can serve as analogs for extraterrestrial life.	1.5 hrs	$	**Journal**: How does this change your "rules" for where to look on other worlds for living organisms? Does it change the way you would draw an alien? 
Culminating Activity: Now what do you think about the possibility of life on earth?				
Activity 5: Is There Life on Other Worlds? Pages 46-58 Astrobiology: Life Here and Out There	Trainees learn about the Drake Equation as they estimate the number of worlds in the Milky Way galaxy that have life.	1.0 hrs	None 	This can also be done online at: http://www.planetarysystems.org/

Three-Day Camp – Day Two: Life Science

Title	Overview	Time	Cost	Additional Resources
Opener: Should Earth be called Earth?				
Water, Water Everywhere Lesson	The entire group makes a circle and tosses an inflatable Earth globe to determine the percentage of water vs. land on Earth by counting the number of times the thumb lands on earth or water as they catch the globe.	0.5 hrs	$	**Tip:** The results are tabulated on a poster to determine percentages. 
Engage: What is life?				
What is Life?	In this activity, trainees define life by using various examples and non-examples such as: an apple and banana, an Apple Logo, a plastic spider and ant, a live ant and dead spider, leaves (green and dried), grass, a plastic model banana.	0.5 hrs	$	
Explore: What is the water cycle?				
Around and Around It Goes	Using cups and sentence strips, trainees follow a drop of water to learn about the water cycle.	1.0 hrs	$	
Explain: How much water is drinkable?				
Water, Water Everywhere Video: The Case of the Wacky Water Cycle NASA - Earth Science Week 2009: Videos	A demonstration to show the percentage of drinking water on the Earth by using plastic gallons, plastic quart and pint bottles and an eyedropper for the final part of the demonstration. Trainees view the film that goes with the lesson online.	1.0 hrs	$	**Journal:** What percentages make up: Oceans, Ice, aquifers, rivers, lakes, drinking water? Is water necessary for life on Earth? What about life in other worlds? 
Elaborate: Is water necessary for life?				
Astrobiology: Life Here and Out There Page 6	Trainees compare three “mystery” samples (yeast, ground antacid and salt) to determine which sample yields a life form. Trainees add warm water and	1.0 hrs	$$	

	sugar to each sample and make observations.			
Evaluate: How can we "see" microscopic life?				
Simple Magnifiers	Trainees learn about how magnifiers help us observe life by observing how a simple drop of water can magnify objects. Trainees then work with jars and bottles to see how light waves can be manipulated to magnify.	1.0 hrs	$	
Culminating Activity: Now what do you think about the possibility of life on other worlds?				
Observing Cells The Brain in Space Educator Guide Lesson 1 pp. 40-43	Trainees observe various cells such as cheek, hair, muscle and bone cells. This can be done using microscopes and slide prepared with student cheek and hair cells and/or prepared slides observed under a microscope or trainees can use the internet to "collect" images of cheek, hair, muscle, blood and bone cells. They can also collect images of other one-celled creatures such as amoebas, bacteria, and viruses.	1.0 hrs	$$ 	Video: Single-celled Organisms **Journal:** Most Hollywood movies portray aliens as human-like creatures but most scientists have evidence to prove that alien life may be single cellular. Based on this evidence, what kind of alien life would we be most likely to find in other worlds? 

Three-Day Camp – Day Three: Life Science

Title	Overview	Time	Cost	Additional Resources

Opener: Searching for life in other worlds?				
Opening Activity: Destination Mars Educator Guide: Lesson 6	Using a different poster board for each letter of the word “Explore”, trainees work in groups to read a paragraph that gives reasons why humans explore space. Trainees then illustrate their poster and report to the group about what they learned and how they worked together to illustrate their reasons for exploring.	1.0 hrs	$	
Engage: How can we train like an astronaut?				
Reflection of Light With a Plane (Flat) Mirror -- Trace a Star (K-8)	Trainees learn about disorientation similar to what astronauts encounter in microgravity. Trainees use mirrors to test their skill completing a maze with their left and right hands.	1.0 hrs	$	**Journal:** What might an alien look like if he came from a planet with more gravity than ours? What if he came from a planet with less? 
Explore: What other factors do astronauts have to overcome?				
Vomit Comet Page 44	Trainees learn that motion can cause disorientation and understand why astronauts train to live and work in space.	0.5 hrs	$	
Explain: What happens to bones in space?				
Inner Space in Outer Space Educator Guide: Activity 1 Bag of Bones Pages 9-12	Trainees simulate bone density as they investigate life in space by using cereal in zip-lock bags.	1.0 hrs	$$	
Elaborate: How can we keep astronauts healthy in space?				
Food Preparation for Space	Trainees explore how to keep astronauts happy and healthy in space.	0.5 hrs	$	**Journal:** What might food for your alien look like? 
Evaluate: How can we simulate the fluid shift felt by astronauts when they enter space?				
Space Adaptations	The Body Unit, Space Adaptations Lesson; Activity:	1.0 hrs	$	Teacher Guide

Get a Leg Up	Get a Leg Up			Student Guide
Culminating Activity: Now what do you think about the possibility of life on Earth?				
Create a Biosphere Don't Burst My Bubble NASA "Why" Files Inhabitable Habitat	Each student now gets their sticky note from the giant graph on the board that they made in the morning and once again answers the question: Do you believe in the possibility of alien life: Yes, No, Maybe Culminating activity: Trainees will create their own worlds, and a variety of types of beings that could live on them. Using a tarp, trainees create a Biosphere.	1.0 hrs	$$ 	Trainees should be prepared to demonstrate and describe for their parents in an open house or at home. 

Weeklong – Day One: Life As We See It!

In day one, trainees think about the choices people make about the environments they choose to live in. Later in the week, we can use that understanding to begin to think about how to look for life on other worlds.

Title	Overview	Time	Cost	Additional Resources
Engage: Where do we choose to live and why?				

Opening Activity Astrobiology: Science Learning Activities for Afterschool	Draw a picture of an alien in your journal (or as the cover of your journal) – something you think you might see on another planet or in space. Describe each part on it, and why you added those parts.	30-45 min	$	NASA Astrobiology
Where Do We Choose To Live and Why? United States at Night	Trainees construct an image of the United States at night to learn about human settlement on Earth based on the pattern of lights observable and make inferences based on their observations.	2.0 hrs	$	Video: Life Built with Toxic Chemicals
Explain: What is Astrobiology?				
What is Astrobiology?	Trainees get background information on what Astrobiology is and why it is important.	0.5 hrs	$	**Journal:** Why was it hard to determine which of the items you viewed were living? Can you think of other objects that would be difficult to determine if they are alive or not?
Elaborate: Is it alive?				
Astrobiology: Life Here and Out There Lesson 1 Page 6	Trainees compare three "mystery" samples (yeast, ground antacid and salt) to determine which sample yields a life form. Trainees add warm water and sugar to each sample and make observations.	1.0 hrs	$$	
Evaluate: What does life need to live?				
What is Life?	In this activity, trainees define life by using various examples and non-examples such as: an apple and banana, an Apple Logo, a plastic spider and ant, a live ant and dead spider, leaves (green and dried), grass, a plastic model banana.	1.0 hrs	$$	

Weeklong – Day Two: Taking a Closer Look at Life!

Title	Overview	Time	Cost	Additional Resources
Engage: How do magnifiers help us observe life?				
Simple Magnifiers	Trainees learn about how magnifiers help us observe life by observing how a simple drop of water can magnify objects. Trainees then work with jars and bottles to see how light waves can be manipulated to magnify.	0.5 hrs	$	
Explore: Is It living or non-living?				
Is it Living? Astrobiology: Science Learning Activities for Afterschool	Trainees go outside to observe and study living things defining what is "alive" and what is not helping them refine their understanding of life.	1.0 hrs	$	
Explain: Which one is alive?				
Astrobiology: Life Here and Out There Lesson 1 Page 6	Trainees compare three "mystery" samples (yeast, ground antacid and salt) to determine which sample yields a life form. Trainees add warm water and sugar to each sample and make observations.	1.0 hrs	$	
Elaborate: What cells can I see?				
The Brain in Space Educator Guide Lesson 1 Pages 40-43	Trainees observe various cells such as cheek, hair, muscle and bone cells. This can be done using microscopes and slide prepared with student cheek and hair cells and/or prepared slides observed under a microscope or trainees can use the internet to "collect" images of cheek, hair, muscle, blood and bone cells. They can also collect images of other one-celled creatures such as amoebas, bacteria, and viruses.	1.0 hrs	$$ 	**Journal:** Most Hollywood movies portray aliens as human-like creatures but most scientists have evidence to prove that alien life may be single cellular. Based on this evidence, what kind of alien life would we be most likely to find in other worlds? 
Evaluate: Are microbes alive?				

Astrobiology: Science Learning Activities for Afterschool curriculum guide Activity 5 Is it Living? Pages 19-21	Trainees observe mold growing on potatoes, oranges, and bread (sealed in plastic bags) with magnifiers and then observe images of several different microbes.	1.0 hrs	$ 	**Journal:** Were you surprised to think of these microbes as living things? How does this change your view of what life might look in another world? 
Excite: What can we learn from living organisms?				
Observing Life	Trainees observe living animals structure and movement such as: What does this animal need to survive? How does this animal breathe? How does this animal eat? How does this animal move? How does this animal live? This activity can be done as an internet research project.	0.5 hrs	None, to $$ 	**Journal:** How might you change the picture of your alien now? Draw a new one, or describe what changes you would make now to your drawing?  

Weeklong – Day Three: What Can Be Learned About Life?

Title	Overview	Time	Cost	Additional Resources
Engage: What does life need to live?				
Life, Here and Elsewhere Activity 2; pp.12-22 Activity Guide pp., 16-17 Astrobiology: Life Here and Out There	Trainees grow organisms in one of 12 classroom environments and identify requirements (e.g. water, nutrients, and energy) for life. While trainees may not see much growth in two days, hopefully they will continue to experiment at home. A PowerPoint slide show can show pictures of growth over a period of time. Trainees Design a mission to identify habitable places by searching for water, nutrients, and energy. Trainees will continue to watch their mini-environments during the week and keep data in their journals on their mini-environments.	2.0 hrs	$ 	Trainees make a "Math Connection" by measuring calories using a peanut. Trainees will see how food provides energy. **Tip:** You will need the Teacher Notes Page on the 12 Environment for Growing Organisms
Explore: What makes a world habitable?				
What can life tolerate? Activity 4 Pages 37-48	Working as a group, trainees explore what makes a world habitable by matching planet cards and inferring habitability based on what they have learned about life on earth.	1.5 hrs	$	**Journal:** What surprised you about today's activity? Where on Earth would you feel most comfortable living and why? 
Explain: What can life tolerate?				
Astrobiology: Life Here and Out There Pages 23-36	Trainees match sets of cards to determine that organisms living under extreme conditions on Earth can serve as analogs for extraterrestrial life.	1.0 hrs	$	**Journal:** How does this change your "rules" for where to look on other worlds for living organisms? Does it change the way you would draw an alien? 
Elaborate: What have we learned?				
Reviewing Notes,	Trainees review notes and journal entries and	0.5 hrs	None	

Discussion, and Reflection Ending with Group Consensus	discuss what big ideas they have explored so far. Working in groups, trainees will post big ideas from group consensus.			

Weeklong – Day Four: Do Aliens Exist?

Title	Overview	Time	Cost	Additional Resources
Engage: Do you think aliens exist?				
Do You Think Aliens Exist? Pages 7-9	Trainees discuss the possible existence of alien life and then survey the group to record and graph opinions. Give trainees a sticky note and have them "graph" their opinions on the board.	1.0 hrs	$	**Journal:**  Trainees use their science journals to write about and illustrate their ideas including criteria they use to look for life on other worlds. What environments would these aliens live in?
Explore: Is there life on other worlds?				
Activity 5: Is There Life on Other Worlds? Pages 46-58	Trainees learn about the Drake Equation as they estimate the number of worlds in the Milky Way galaxy that have life.	1.0 hrs	None	This can also be done online at: http://www.planetarysystems.org/
Explain: What about animal life?				
Animal Antics	Trainees discuss how scientists classify animal life and model their own classification key. Trainees construct a booklet and learn about scientific animal classification. Trainees then form groups to discuss where the animals they have studied would fit into the classification and what kind of life we would discover in space.	2.0 hrs	$	**Tip:** Working in groups, trainees create an alien and his world. Trainees will then vote on the best model.
Elaborate: Now what do you think about the possibility of life in the universe?				
Activity 8: Now What Do You Think About the Possibility of Life in the Universe? Pages 28-29	Trainees reexamine their own thinking, then take a new survey to find out if they have changed their opinions because of new information,	1.0 hrs	$	

Weeklong – Day Five: How Can We Live in Space?

Title	Overview	Time	Cost	Additional Resources
Engage: Can we simulate space disorientation?				
Mirror Disorientation Activity: Reflection of Light With a Plane (Flat) Mirror -- Trace a Star (K-8)	Trainees learn about disorientation similar to what Astronauts encounter in Microgravity. Trainees use mirrors to test their skill completing a maze with their left and right hands.	1.0 hrs	$	**Journal:** What might an alien look like if he came from a planet with more gravity than ours? What if he came from a planet with less? 
Explore: Can we simulate motion in microgravity?				
Vomit Comet Page 44	Trainees learn that motion can cause disorientation and understand why astronauts train to live and work in space.	1.0 hrs	$	
Explain: What happens to bones in space?				
Inner Space in Outer Space Educator Guide Activity 1 Bag of Bones Pages 9-12	Trainees simulate bone density as they investigate life in space by using cereal in zip-lock bags.	1.0 hrs	$$	
Elaborate: How can we learn about food in space?				
Food Preparation for Space	Trainees explore how to keep Astronauts happy and healthy in space.	1.0 hrs	$	**Journal:** What might food for your alien look like? 
Evaluate: How can we simulate the fluid shift felt by astronauts when they enter space?				
Space Adaptations Get a Leg Up	Trainees will investigate how an Astronaut's body adapts to microgravity by measuring the circumference of their legs, face, and neck before and during the simulation.	1.0 hrs	$ 	Teacher Guide Student Guide
Culminating activity:				

Create a Biosphere Don't Burst My Bubble NASA "Why" Files Inhabitable Habitat	Trainees will create their own worlds, and a variety of types of beings that could live on them. Using a tarp, trainees create a Biosphere. If photos are taken of activities throughout the week, they can also be posted to guide discussions about their learning.			**Tip:** Trainees should be prepared to demonstrate and describe for their parents in an open house or at home.